

**2/M—24 (vii) (Syllabus—2005)**

**2009**

**PHYSICS**

**( Honours )**

**SEVENTH PAPER (Phys-223)**

**( Electromagnetic Theory, Relativity and  
Classical Mechanics )**

*Full Marks : 60*

*Time : 3 hours*

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*The figures in the margin indicate full marks  
for the questions*

*Answer any five questions*

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1. (a) If the components of a tensor of any rank is zero in one coordinate system, then prove that the components are zero in all coordinate systems. 4
- (b) Show that a tensor of second rank can be written as a sum of a symmetric and an antisymmetric tensor of the same rank. 3
- (c) Show that Kronecker delta function is a tensor of rank two. 5

2. (a) Establish the Poisson equation relating the charge density to the second derivative of the potential. 6

(b) Using Maxwell equations, show that magnetic and electric fields can be expressed in terms of scalar and vector potentials. 6

3. Obtain the wave equation from Maxwell equations. Derive the plane wave solution from the wave equation. Establish the orthogonality of  $\vec{E}$  and  $\vec{B}$  with respect to the propagation vector. 3+6+3=12

4. (a) Prove that the electromagnetic wave ~~propagating in conductors shows atten-~~ uation, and find the skin depth. 5+3=8

(b) Explain what is meant by retarded potential. 4

5. (a) ~~Show that for small velocities the Lorentz transformation equations reduce to the Galilean transformation equations.~~ 3

(b) Derive the relativistic formula for the addition of velocities. Show that it verifies the postulate of the constancy of the velocity of light. 4+2=6

(c) An electron of rest mass  $9.1 \times 10^{-31}$  kg is moving with a speed of 0.99 C. What is its total energy? 3



6. (a) What are generalised coordinates? What is the advantage of using them? Derive Hamilton's canonical equations of motion in generalised coordinates.

2+1+5=8

- (b) Obtain Lagrange's equation of motion for a simple pendulum placed in a uniform gravitational field.

4

7. (a) Define differential scattering cross-section. Derive an expression of scattering cross-section when a uniform beam of particles, all of the same mass and kinetic energy, incident upon the centre of force.

2+4=6

- ~~(b) An artificial satellite of mass  $m$  moves in a circular orbit about the earth at a constant speed  $v$  and at an altitude  $h$ , above the earth's surface. Determine the period of revolution of the satellite around the earth. How to put a geostationary satellite into orbit?~~

3+3=6

8. Write short notes on any *two* of the following :

6×2=12

- (a) Betatron and its applications  
(b) Uniqueness theorem of electrostatics  
(c) Poynting theorem  
(d) Mass-energy equivalence

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